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# Hidden Markov Models: a data assimilation-like approach for Geosciences

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Data assimilation can be defined as a process by which observations are incorporated into a numerical model representation of a real system. In geosciences, the prevalent methodologies are those of Kalman filtering and 4D-Var data assimilation. These methods are very accurate but are relativelly hard to implement and necessitate a lot of computational power.

We propose an alternative method, named PROFHMM, for "PROFile reconstruction with HMM" that combines the dynamic of the model and the available time series of observations in order to estimate the most likely evolution of the model without executing the model itself. This is done by simplifying the dynamic model by transforming it into a multiple-state Hidden Markov Model (HMM). The reconstruction of the evolution of the model is done by applying a modified version of the Viterbi algorithm. PROFHMM makes use of Self Organizing Maps to generate the hidden and observable states of the model, and takes into account the topological aspect of the Self Organising Maps to enhance the estimation of the probabilities of the HMM.

This method has the advantages of being relatively easy to implement, and having a minimal computational cost after the initial quantification of the model and the estimation of the probabilities, while having good performances.

In order to demonstrate the capabilities of the method we present two applications of the method.
The first one is on the inversion, from satellite imaging, of the temporal evolution of the vertical distribution of chlorophyll-a in one spot in the ocean. The second one demonstrates the ability of generating a statistical model from real data, by presenting the inversion of the spatial evolution of temperature profiles in the ocean based on in-situ measurements and satellite data.